



INFANTS' PERCEPTION OF NATIVE AND NON-NATIVE PITCH CONTRASTS: TUNE, PITCH ACCENT OR TONE?

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BACKGROUND & GOALS



My language?

- Infants' ability to distinguish between forms of phonetic variation in speech that are relevant to meaning is essential for their language development
- Learning a language >> a stronger commitment to the native language as development proceeds, modulated by perceptual assimilation and phonetic salience (e.g., Kuhl 2004, Safran et al. 2006, Best & Roberts 2003, Narayan et al. 2010)
- Across languages, pitch can mark prominence, edges, distinguish between sentence types, as in intonation languages like English or Portuguese, or signal differences in word meanings, as in a tone language like Mandarin or a pitch accent language like Japanese

BACKGROUND & GOALS



My language?

Lexical	Limited variation	Segmental variability
Stress	✓	✗ only after 6 mos & native (e.g., Skoruppa et al. 2013)
Tone	✓ as early as 4 mos, but only tone learners > 6 mos, unless very salient (Mattock & Burnham, 2006; Yeung et al, 2013; Liu & Kager, 2014)	✗? only after 6 months, native (Shi, 2010)
Pitch accent		✓ as early as 4 mos, for Japanese learners (Sato et al., 2009)

BACKGROUND & GOALS



My language?

Developmental course of infants' perception of pitch contrasts, in the presence of **segmental variability** >> the ability to extract and generalize the contrastive patterns.

Intonation	Limited variation	Segmental variability
Tune	✓ as early as 4 mos, English-learning infants (non-native tune contrasts - Sundara et al. 2015)	✓ as early as 4-5 mos, Portuguese learners (native – Frota et al. 2014); ✓ Basque (non-native); ✗ English (non-native) – Sundara et al. 2015)

- Portuguese-learning infants discriminate the statement (falling)/yes-no question (falling-rising) native intonation contrast as early as 5-months (Frota et al. 2014)
- Non-native discrimination of the Portuguese contrast has different outcomes in English-learning and Basque-learning infants (Sundara et al., 2015)

BACKGROUND & GOALS



My language?

Do Portuguese-learning infants also perceive the salient contrast in pitch (falling/low versus falling-rising/high) in segmentally varied non-native input? (Mandarin Chinese Tones and Japanese Pitch accents)

Similar overall contour shapes
predict early discrimination

Effects of language experience
predict NO discrimination

Pitch accent contrast expected to be closer to the tune than the lexical tone contrast (word vs. syllable domain)

EXPERIMENT 1

Native pitch contrast: falling (statement) versus falling-rising (yes-no question) intonation (Frota et al. 2014)

Participants

5-6 month-olds, n=20:

Mean age= 5 mos 29 days; 8 girls

Range= 5 mos 3 days – 6 mos 23 days

8-9 month-olds, n=20:

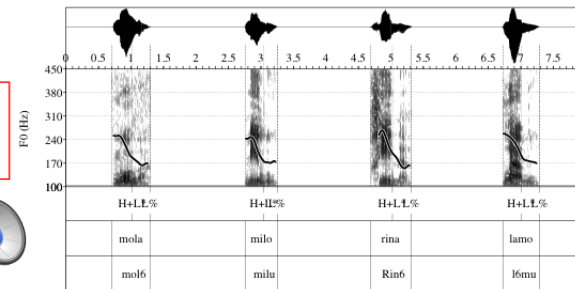
Mean age= 8 mos 12 days; 10 girls

Range= 7 mos 11 days – 9 mos 29 days

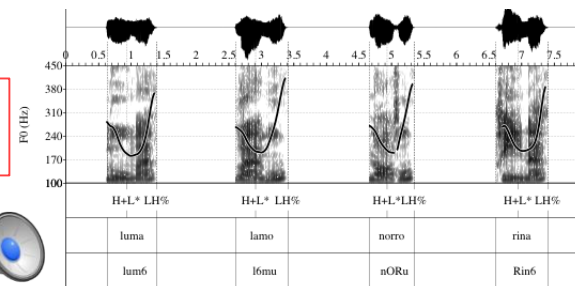
Materials

Segmentally varied, single-prosodic word utterances produced in IDS (11 ≠ segments, bisyllabic utterances)

Declarative intonation



Question intonation



EXPERIMENT 1

Native pitch contrast: falling (statement) versus falling-rising (yes-no question) intonation

VISUAL HABITUATION PROCEDURE

Habituation

malo, lemo,
mela, nirra...



Test

luma, milo, rina,
lamo...

Same

Switch

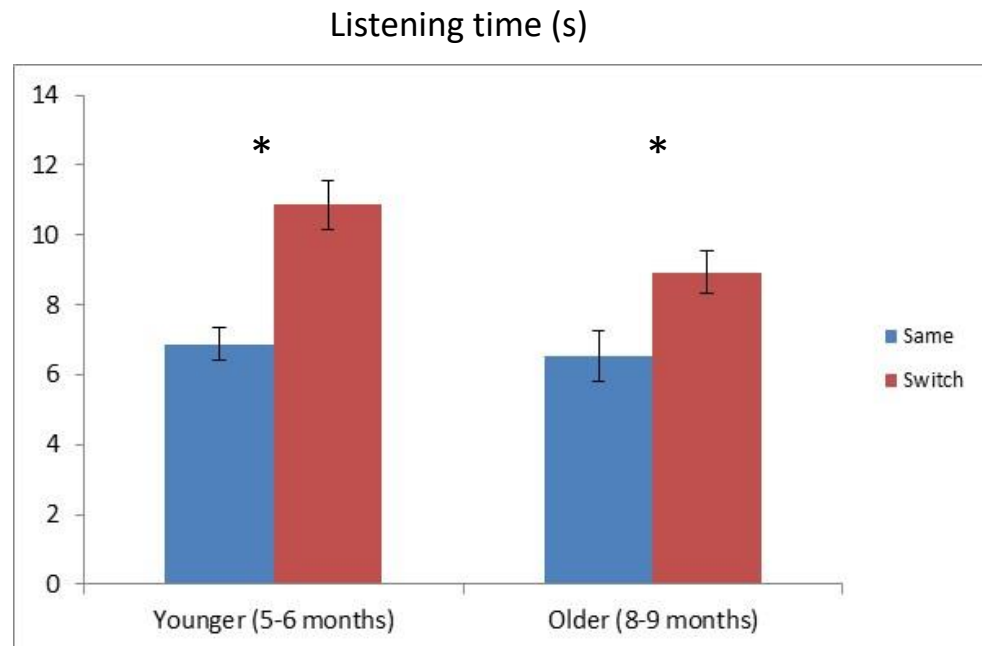


Different pseudo-words used for the habituation and test phase

EXPERIMENT 1

Native pitch contrast: falling (statement) versus falling-rising (yes-no question) intonation

Results



EXPERIMENT 2

Non-native Tone contrast: Tone 1+Tone 4 and Tone 1+Tone 2 in Mandarin Chinese (also a falling versus falling-rising pitch contrast)

Participants

5-6 month-olds, n=20:

Mean age= 5 mos 25 days; 8 girls

Range= 5 mos 2 days – 6 mos 19 days

8-9 month-olds, n=20:

Mean age= 8 mos 21 days; 10 girls

Range= 7 mos 13 days – 10 mos 8 days

Materials

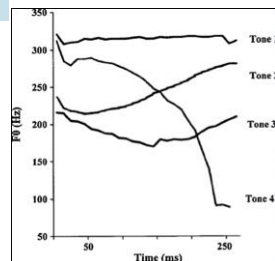
Tone1+Tone4

≡ declarative intonation

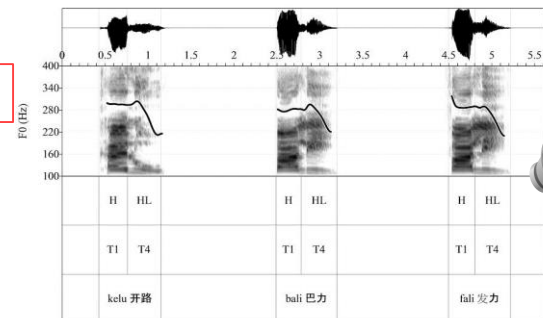
Tone 1 + Tone 2

≡ question intonation

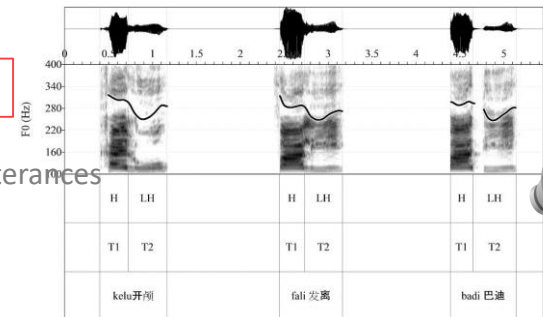
(Braun & Johnson 2011)



Tone 1 + Tone 4



Tone 1 + Tone 2



Segmentally varied
produced in IDS
(13 ≠ segments, bisyllabic)

Wang et al. 2001

EXPERIMENT 2

Non-native Tone contrast: Tone 1+Tone 4 and Tone 1+Tone 2 in Mandarin Chinese (also a falling versus falling-rising pitch contrast)

Materials

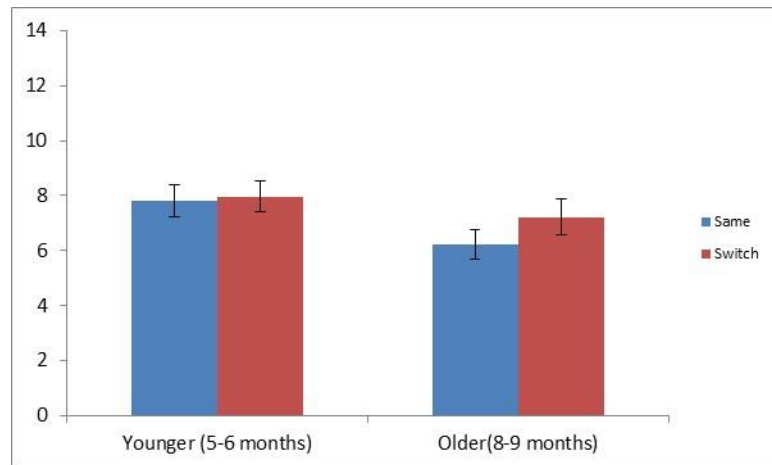
Same procedure

Results

	Tones14/12	Stat/Quest	t-test Man/EP
F0 patterns 1 st syll	H / H	HL / HL	-
F0 patterns 2 nd syll	HL / HLH	L / LH	-
F0 range 2 nd syll (Hz)	103/35	25/192	$p < .001 / p < .001$
Duration 1 st syll (ms)	270/279	310/397	$p = .07 / p < .001$
Duration 2 nd syll (ms)	493/522	310/437	$p < .01 / p < .01$

Similar overall contour shapes, but
differences in how the contours
relate to the text

Listening time (s)



EXPERIMENT 3

Non-native Pitch accent contrast: HL and LH word patterns in Japanese (also a falling versus rising pitch contrast)

Participants

5-6 month-olds, n=24:

Mean age= 6 mos 3 days; 11 girls

Range= 4 mos 28 days – 7 mos 11 days

8-9 month-olds, n=24:

Mean age= 9 mos 3 days; 13 girls

Range= 7 mos 19 days – 10 mos 20 days

Materials

HL words

≡ **declarative intonation**

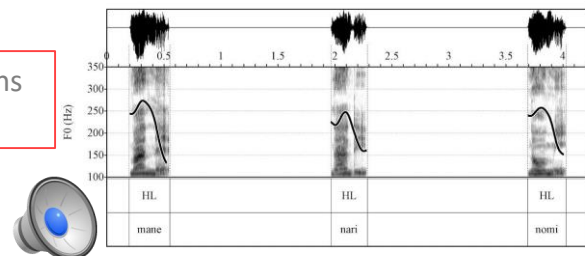
LH words

≡ **question intonation**

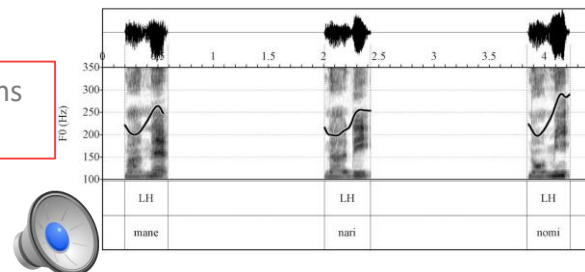
(materials from Sato, Sogabe & Mazuka 2009)

Segmentally varied utterances
produced in IDS
(12 ≠ segments, bisyllabic)

HL word patterns



LH word patterns



EXPERIMENT 3

Non-native Pitch accent contrast: HL and LH word patterns in Japanese (also a falling versus rising pitch contrast)

Materials

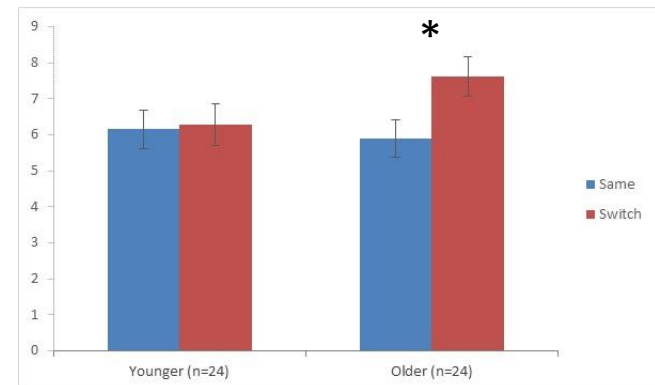
	HL/LH	Stat/Quest	t-test Jap/EP
F0 patterns 1 st syll	H / L	HL / HL	-
F0 patterns 2 nd syll	L / LH	L / LH	-
F0 range 2 nd syll (Hz)	122/75	25/192	$p < .001$ / $p < .001$
Duration 1 st syll (ms)	141/165	310/397	$p < .01$ / $p < .001$
Duration 2 nd syll (ms)	190/232	310/437	$p < .001$ / $p < .01$

Similar overall contour shapes, but also **differences** in how the contours relate to the text

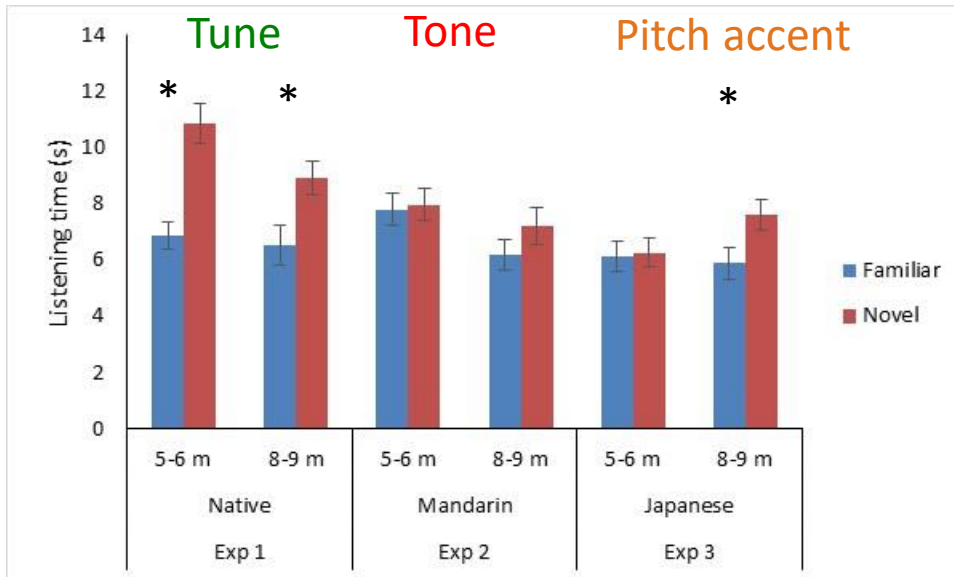
Same procedure

Results

Listening time (s)



COMPARING THE 3 EXPERIMENTS



Findings support differences in discrimination abilities, with Pitch accent contrast easier to perceive, and closer to Tune, for older infants

A GLMM was used (along the lines of Skoruppa et al. 2013)

- Effect of **language** ($F(2,122) = 8.26, p < .001$)

. Borderline **interaction Language x Age** ($F(2,122) = 2.91, p = .058$)

EP vs. Mandarin: only an effect of **language** ($F(1,76) = 15.28, p < .001$)

EP vs. Japanese: effect of **language** ($F(1,84) = 11.7, p < .01$) and **interaction Language x Age** ($F(1,84) = 5.68, p < .05$)

DISCUSSION



My language!

Infants discriminated the **native intonation** contrast at 5-6 and 8-9 mos

Results for **non-native** pitch contrasts were NOT alike:

- Infants failed to discriminate the **non-native tone** contrast at both ages
- Discrimination of the **non-native pitch accent** contrast was easier for older infants

Segmental content was controlled to be native-like (inventory), analogous in degree of segmental variability, and comparable in frequency of occurrence

DISCUSSION



My language!

- Results suggest that the similar contour shapes of lexical pitch were **not *similar* enough** to intonation to be fully perceived as native: No precocious discrimination abilities for pitch regardless of language experience
- Japanese **Pitch accent** contrast closer to the native **tune** than the Mandarin **lexical tone** contrast

Tune \approx **Pitch accent** vs. **Tone**:
utterance/word domain vs. syllable domain

Language-specific perception for pitch emerges as early as 5 months of age, and the tune, pitch accent and tone distinction are already differentially perceived in the first year of life

DISCUSSION



My language!

- Further research into the language-specific aspects behind infants' precocious sensitivity to pitch differences across languages is needed (ongoing work)
- One avenue: Further explore the impact of phonetic detail
 Better control of phonetic segmental differences
 Pitch range differences and salience: e.g., Falling wider in Mandarin and Japanese;
 Rising wider in Portuguese

Language-specific perception for pitch emerges as early as 5 months of age, and the tune, pitch accent and tone distinction are already differentially perceived in the first year of life

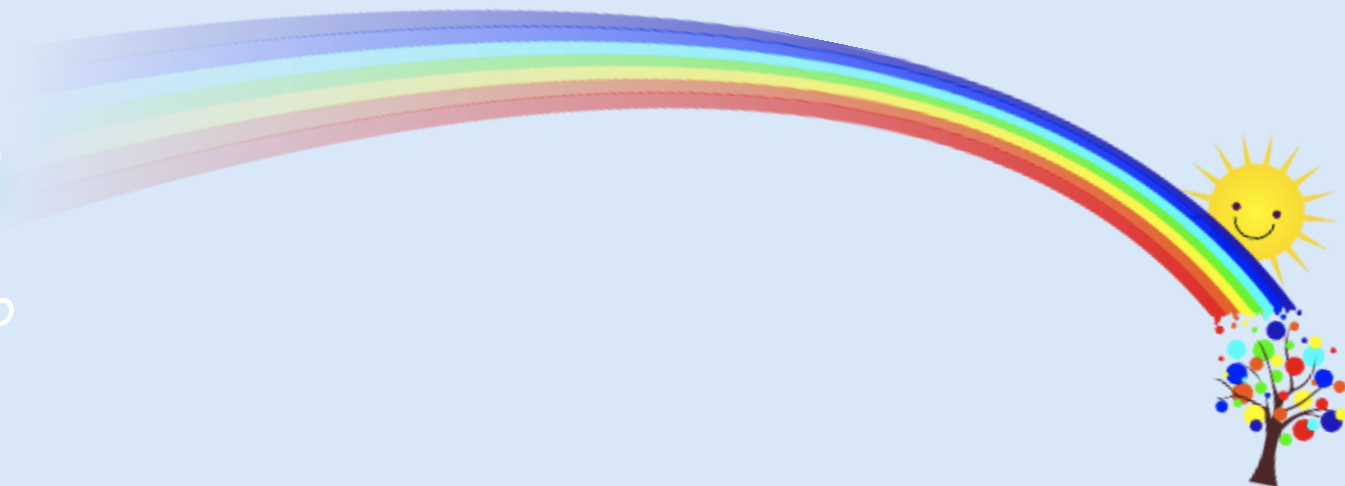


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Obrigado!
Thank you !



Lisbon Baby Lab



Mandarin materials

Tone1 (level) + Tone2 (Rising)	Tone1 (level) + Tone4 (Falling)
Ba1di2 巴迪	Ba1di4 巴蒂
Ba1du2 八毒	Ba1du4 八度
Ba1li2 巴黎	Ba1li4 巴力
Ba1lu2 八炉	Ba1lu4 八路
Bo1li2 剥离	Bo1li4 剥立
Di1su2 低俗	Di1su4 低速
Fa1li2 发离	Fa1li4 发力
Go1di2 高迪	Go1di4 高蒂
Go1du2 高独	Go1du4 高度
Go1li2 高离	Go1li4 高丽
Gu1du2 孤独	Gu1du4 孤肚
Gu1li2 孤离	Gu1li4 孤立
Ke1fu2 开服	Ke1fu4 开赴
Ke1li2 开犁	Ke1li4 开例
Ke1lu2 开颅	Ke1lu4 开路
Pa1bi2 趴鼻	Pa1bi4 趴壁

The current study	Frota, Butler & Vigário (2014)
Syllables: 32	Syllables: 32
Consonants: 8 (b, d, l, k, s, g, f, p)	Vowels: 7
Vowels: 5 (a, i, o, u, e)	Consonants: 4 (l, m, n, r)
Distribution of consonant: 0.25	<u>Distribution of consonants: 0.125</u>
Distribution of vowel: 0.156	<u>Distribution of vowels: 0.21875</u>
Overall variation: 0.406	<u>Overall variation: 0.344</u>

Benavides-Varela
et al. (2012)

Japanese materials

HL	LH
aji	aji
ame	ame
furi	furi
iji	iji
kame	kame
kami	kami
kiri	kiri
mane	mane
nari	nari
nomi	nomi
sumi	sumi
tabi	tabi
umi	umi
uri	uri

Current study	Frota et al. 2014
Syllables: 28 Consonants: 7 Vowels: 5 Distribution of C: 0.25 Distribution of V: 0.18 Overall variation: 0.429	Syllables: 32 Consonants: 4 Vowels: 7 Distribution of C: 0.13 Distribution of V: 0.22 Overall variation: 0.344

Higher vowel variation in the native experiment >> more difficult to perceive the prosodic contrast (Benavides-Varela et al. 2012)

V variation: EP 0.22 > Jap 0.18 > Man 0.16

Overall variation:

Jap 0.429 > Man 0.406 > EP 0.344